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WITNESS my hand this
First day of December 2004

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AUSTRALIA
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PROVISIONAL SPECIFICATION
FOR A PROVISIONAL PATENT

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Invention Title: **Inline And Other Fasteners**

The following statement is a description of this invention

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This invention relates to inline and other fasteners. This invention is concerned, not necessarily exclusively, with fastener assemblies which can be useful for locks, latches, closures and the like.

The invention is at least partly based on the need to provide a fastener assembly of sufficiently slim profile to be able to be concealed within elements having at least one narrow dimension, for example, having a thickness of between 15 and 20mm. It is to be appreciated that the scope of the invention is not necessarily limited to this application, however.

This invention provides a fastener assembly including:

an engagement means movable between a locking position and an unlocking position;

biasing means urging the engagement means towards the locking position; and

means for drawing the engagement means from the locking position to the unlocking position;

wherein the drawing means comprises or includes material adapted to contract when activated.

The fastener assembly of the invention is preferably capable of construction on a small scale so that, possibly with the exception of the engagement means, it has a cross sectional dimension of less than 10mm. The purpose of this is so that the fastener assembly of the invention can be inserted into a panel, such as a panel for an aircraft which has a thickness of around 15 to 20mm. It is of course possible to provide the fastener assembly of the invention on a larger scale for other purposes.

The engagement means may take any desirable configuration. Some examples are illustrated in the accompanying drawings. By way of non-limiting illustration, the engagements means may include a pair of arms or jaws which can engage a latch, bar or projection. By way of different illustration, the engagement means may include a rod or tongue which bears against a closure, preventing movement of the closure towards the engagement means when the engagement means is in a locking position, or a cavity into which the rod or tongue may be received in the locking position. Other configurations will be apparent to one skilled in the art.

The biasing means urging the engagement means towards the locking position is preferably a coiled spring, positioned in the fastener assembly of the invention so that

the spring urges the engagement means toward the locking position. When the means for drawing the engagement means from the locking position to the unlocking position is activated, this may cause compression of the spring, which accordingly can return the engagement means to the locking position once the drawing means is no longer activated.

The drawings means itself consists of or includes material adapted to contract when activated. This material is preferably shape memory alloy wire. Shape memory alloys are known and are usually made predominantly or wholly of titanium and nickel. They may also include other material, such as aluminium, zinc and copper. A shape memory alloy is capable of adopting one shape below a predetermined transition temperature and changing to a second shape once its temperature exceeds the transition temperature. Conversely, when the shape memory alloy cools below the transition temperature, it is capable of adopting the first shape again.

Shape memory alloy wire currently available, such as that sold under the trade mark Nitinol, is capable of contracting by about 3 percent when activated by heating. Consequently, in order to provide sufficient "travel" in drawing the engagement means from the locking position to the unlocking position, in one embodiment of the present invention the drawing means includes Nitinol wire in a length of 140 to 150mm. It is preferred that the Nitinol wire of this length is provided in a single line and a fastener assembly having this configuration may be referred to as an "inline" fastener assembly. This configuration enables the fastener assembly to have a slim profile, for the purpose of fitting into panels and similar elements, as referred to above.

In other applications, particularly where a slim profile is not a priority, or in those circumstances where a greater amount of "travel" is desirable, the Nitinol wire may be provided over a non-linear path. This may have the effect of permitting the fastener assembly of the invention to be provided in a more compact configuration compared to the inline fastener assembly referred to above. In addition, if, for example, the length of Nitinol wire in a non-linear path was around 200mm, the amount of contraction of Nitinol in its presently available form would be about 6mm. In a non-linear path, the Nitinol wire preferably loops over one or more spindles or rollers. An example is shown in the accompanying drawings.

Activation of the material adapted to contract when activated is preferably achieved through electrical resistance heating, with a wire feed to the fastener assembly.

The fastening system of the invention may be modular, with interchangeable engagement means or drawing means, for example. One engagement means, which may

be in the form of a pair of jaws, may be changed for engagement means which includes a rod, for instance.

The drawing means may be changed; the same engagement means may be joined to a drawing means with a Nitinol wire of a first gauge, or to a different drawing means with a Nitinol wire of a second gauge, thus affecting the strength of the drawing means. As another example, the drawing means having a single Nitinol wire may be replaced with a drawing means having two Nitinol wires, for redundancy (see below).

One application of the fastener assembly of the invention is to provide fastening of an element - such as a panel - in which the fastener assembly is mounted to an external element, such as a latch. As will be appreciated, the engagement means and its type of engagement with the external element may take many different forms. The drawing means may be attached directly to the engagement means or to an intermediate body. This allows a certain amount of flexibility in the design of the engagement means.

Another application of the fastener assembly of the invention is to provide a fuel filler catch in a vehicle. The fastener assembly of the invention may be contained within or close to the fuel filler cavity and effectively concealed from the outside of the vehicle. In this embodiment, the engagement means preferably comprises a rod or tongue which, while the engagement means is in the locking position, prevents removal of the fuel filler cap. Alternately, the engagement means may retain the fuel filler cap through engagement with a latch or similar element on the fuel filler cap.

When the material adapted to contract when activated, such as Nitinol wire, is heated electrically to the desired temperature, the drawing means draws the engagement means out of engagement with the fuel filler cap, allowing removal of the fuel filler cap. Because the engagement means is biased towards the locking position, once the material adapted to contract when activated is no longer activated - for example, when it is allowed to cool, the fuel filler cap may be pushed back into engagement with the engagement means.

The fastener assembly of the invention may have inbuilt redundancy, by including one or more additional materials which contract when activated, such as Nitinol wire. Any of the Nitinol wires would be able to contract when activated; if one wire fails, another can perform the necessary function in the drawing means.

In some embodiments of the fastener assembly of the invention, the drawing means is attached to an electrical system. Use may be made of this so that the fastening system has a switching capacity as a second function. For example, the fastening system of the

invention may also operate to turn lights on or off. This may occur in concert with the locking/unlocking function of the fastening system or independently.

One use of the fastening assembly of the invention is to fasten a closure such as a door in an aircraft, typically for a dogbox or cupboard. The fastening system of the invention may be configured so that, when the engagement means is drawn to the unlocking position, allowing the door to open, the fastening system also causes a light in the dogbox or cupboard to be turned on. Similarly, when the engagement means moves to the locking position, the fastening system may cause the light to be turned off.

In another embodiment, the fastening system includes or is associated with a sensing means, which senses light or temperature (internally or externally of the location of the fastening system), or stress applied to the fastener or its environment. In the case of light sensing, the fastening system may be programmed to turn lights (eg, in the cupboard or dogbox) on or off, depending on the amount of external light sensed. In the case of stress sensing, the sensor may detect stress applied to the fastening system, and report on impending failure of the fastening system, for example. Other embodiments will be apparent to one skilled in the art.

The fastening system of the invention may be networked with others fastening systems, for any desirable purpose, but especially so that failure or overstressing of one fastening system may be compensated for by another fastening system in the network.

The invention will now be described in connection with certain non-limiting embodiments illustrated in the accompanying drawings, in which:

Figure 1 is a cross sectional view of a first embodiment of the fastener assembly according to the invention, in the unlocking position;

Figure 2 is an end view of the latch which is shown in Figure 1;

Figure 3 is a cross sectional view of the embodiment of Figure 1 in the locking position;

Figure 4 is an end view of the embodiment in Figure 3, taken along the line 4-4 in Figure 3;

Figure 5 is a side sectional view of a second embodiment of fastener assembly according to the invention; and

Figure 6 is a side sectional view of a third embodiment of the fastener assembly according to the invention, showing a manual override.

Turning first to Figures 1 to 4, fastener assembly 10 has engagement means 12 movable between the locking position shown in Figure 3 and the unlocking position shown in Figure 1.

Engagement means 12 includes a pair of jaws 14 pivotable at pivot point 16.

Block 18 includes cavity 20 defined by arms 22, base 24 and stop 26.

When engagement means 12 is in the locking position as illustrated in Figure 3, pivot point 16 lies as close to base 24 as possible and stop 26 does not prevent the closing of jaws 14, as illustrated. In contrast, when engagement means 12 is in the unlocking position shown in Figure 1, pivot point 16 is spaced from base 24 and stop 26 forces apart jaws 14, as illustrated.

Block 18 is urged towards engagement means 12, in the locking position, by coil spring 28 which is positioned between block 18 and tube 30.

Block 18 includes projection 32 containing aperture 34 to which is attached smart memory alloy wire 42. Smart memory alloy wire 42 is connected electrically to printed circuit board 38 which in turn is hard wired via wires 40 to an energy source (not shown). Electrical wire 36 completes the circuit for smart memory alloy wire 42.

Fastener assembly 10 is intended to be inserted into the edge of a panel through a round hole or bore in the panel, with wires 40 projecting from the rear of the panel. Jaws 14 engage latch 44 on external element 46, in order to secure the panel (not shown) to the external element.

To attach the panel to the external element, smart memory alloy wire 42 is energised by the external energy source via wires 40 to cause smart memory alloy wire 42 to heat and contract to the position shown in Figure 1. In this position, block 18 has been drawn back so that stop 26 forces jaws 14 apart. The panel is positioned so that jaws 14 are poised around latch 44. At this stage, power to smart memory alloy wire 42 is cut off and smart memory alloy wire 42 cools and elongates to the configuration shown in Figure 3. Coil spring 28 pushes block 18 to the left (towards latch 44). Stop 26 is no longer bearing against the base of jaws 14 and accordingly jaws 14 close as shown in Figures 3 and 4, engaging latch 44. In this way, the panel is fastened to the external element.

To remove the panel, smart memory alloy wire 42 is again energised so that it heats and contracts and fastener assembly 10 assumes the position shown in Figure 1, releasing jaws 14 from latch 44.

As will be apparent to one skilled in the art, the design of engagement means 12 can be varied considerably from that shown in Figures 1 to 4, as can latch 44. Engagement means 12 and block 18 may be provided as a module, replaceable by a different module with a different engagement mechanism.

Fastener assembly 10 as illustrated in Figures 1 to 4 is a type of "inline" fastener.

Fastener assembly 50 illustrated in Figure 5 is another type of "inline" fastener. In this second embodiment, fastener assembly 50 is shown as suitable for use in connection with a fuel filler cap. The engagement means in Figure 5 may be substituted for engagement means 12 in Figures 1 to 4. In Figure 5, the same parts will be given the same numbers as in Figures 1 to 4.

Fastener assembly 50 has engagement means 52 which includes rod 54 (circular in cross section) integral with block 56. Rubber grommet 58 ensures a liquid and gas-tight seal between rod 54 and the mechanism of fastener assembly 50.

Fastener assembly 50 is shown with engagement means 52 in the locking position, so that rod 54 is engaging a fuel filler cap (not shown). Rod 54 may have a squared off end 60 as shown in Figure 5 or a ramped end 62 as shown in dotted outline. The configuration in this regard will depend on the type of engagement between rod 54 and the fuel filler cap.

Coil spring 28 urges engagement means 52 towards the locking position. Shape memory alloy wire 42, activatable as described above, can contract to draw engagement means 52 to the unlocking position, through attachment of shape memory alloy wire 42 in aperture 34 of projection 32 from block 56.

Locking and unlocking generally takes place as described in relation to the embodiment in Figures 1 to 4, in relation to contraction of smart memory wire 42.

It is intended that fastener assembly 50 will be located within or close to the fuel filler cavity of a vehicle, activation taking place as the result of pressing a button on the vehicle dashboard or pressing a button on the vehicle key fob.

The embodiment shown in Figure 6 is a fastener assembly for a fuel filler cap which differs from that in Figure 5 in two respects. Firstly, the embodiment in Figure 6

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permits a longer "travel" for the fuel filler catch. Secondly, the embodiment in Figure 6 includes a manual override in case there is some malfunction of the activation system from the vehicle dashboard or from the vehicle key fob.

In Figure 6, fastener assembly 70 has engagement means represented by tongue 74 which in the locking position protrudes from housing 72. Engagement means 74 is biased towards the locking position, as shown in Figure 6, by coil spring 28, which in this embodiment is positioned between block 76 and housing portion 78.

Shape memory alloy wire 42 is attached at both ends to printed circuit board (PCB) 80 retained in channels 82 within housing 84. Shape memory alloy wire 42 travels from pcb 80, where it is fixed through stop 86, over spindle 88, from there to spindle 90, then to block 76 and returns to pcb 80. This greatly increased the length and doubles the strength of shape memory alloy wire 42 which in turn enables a greater distance of travel for engagement means (tongue) 72.

The embodiment in Figure 6 includes manual override pull 92, which is attached to block 76 by wires 94. Wires 94 are not of shape memory alloy wire and simply provide a mechanical connection between pull 92 and block 76. In case of failure of shape memory alloy wire 42 to be activated through power provided by an external source (not shown) through wires 40, pull 92 may be used to mechanically draw engagement means (tongue) 72 to the right of the position shown in Figure 6, disengaging tongue 72 from the fuel filler cap (not shown).

The embodiments shown in the drawings are mere examples of the fastener assembly of the invention. It will be apparent to one skilled in the art that many modifications and variations may be made to the embodiments described without departing from spirit or scope of the invention.

Dated this 14th day of July 2004

Telezygology Inc.

By its Patent Attorneys

Chrysiliou Law

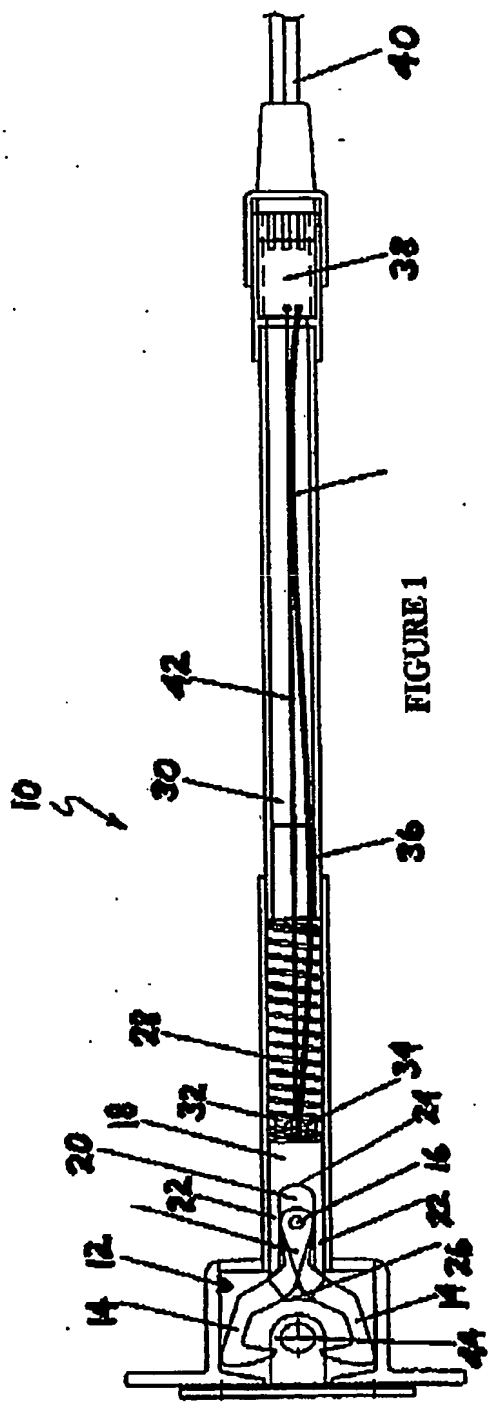

FIGURE 1

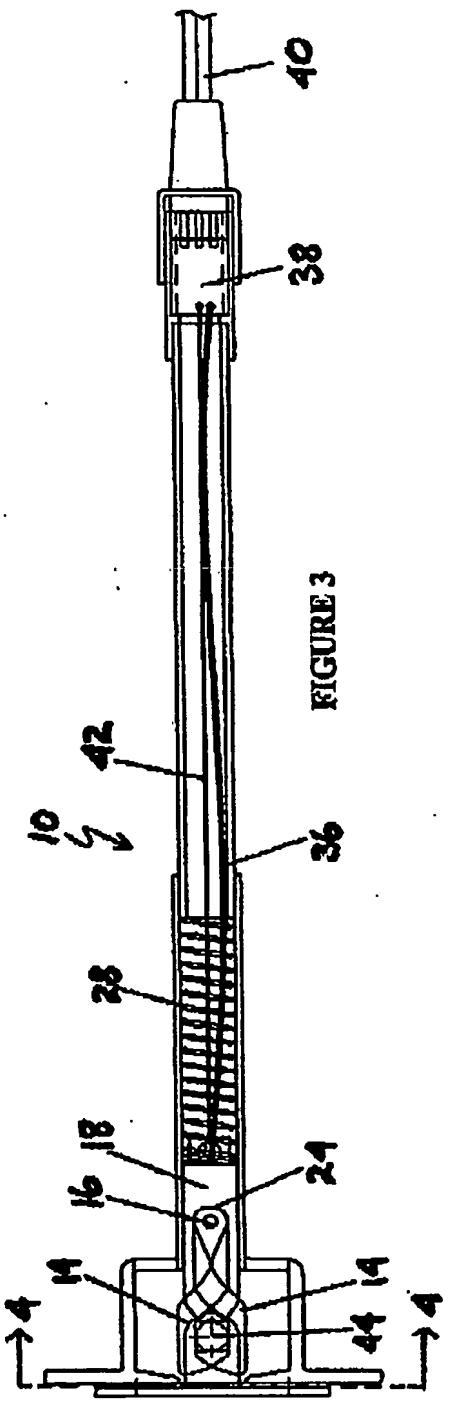

FIGURE 3

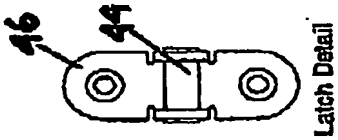

FIGURE 2

Latch Detail

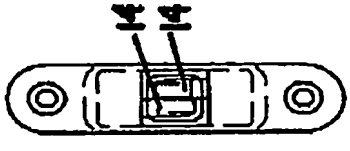

FIGURE 4

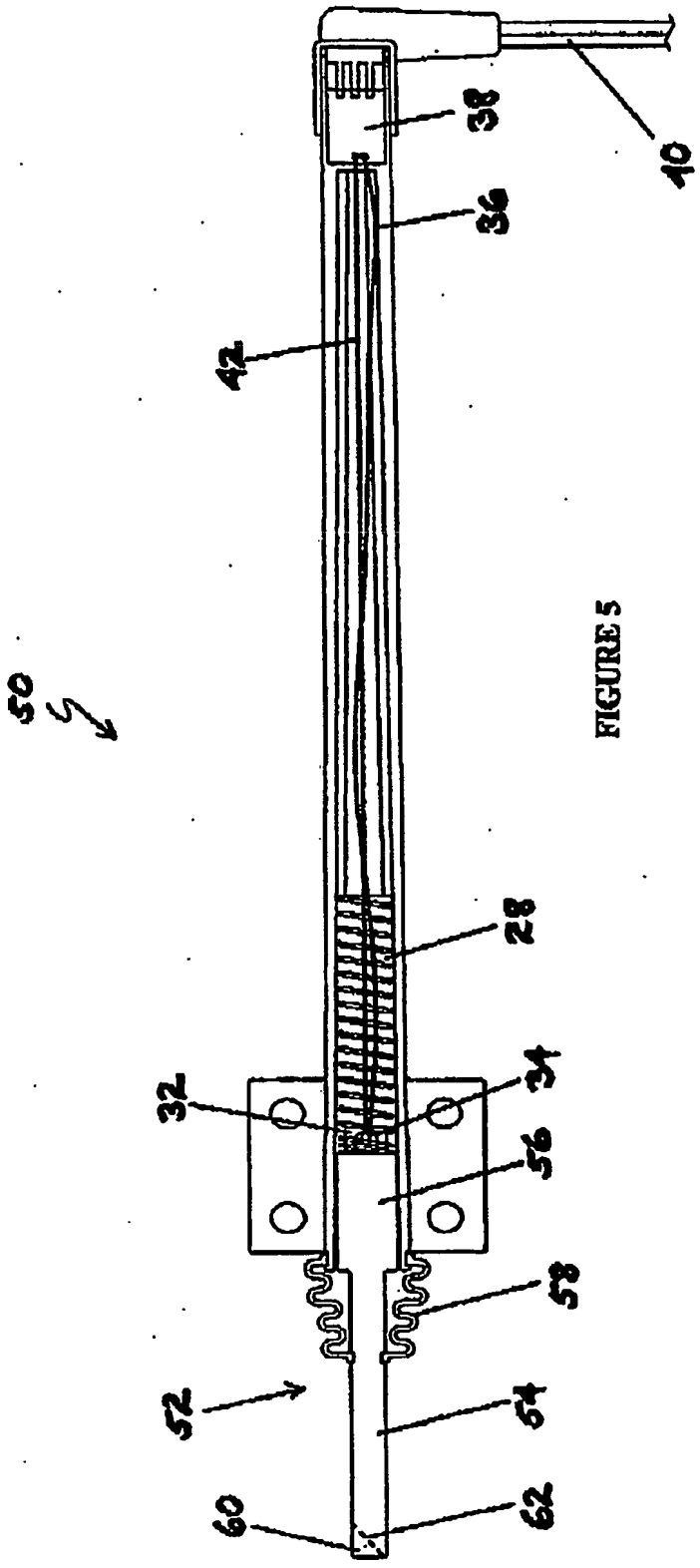

FIGURE 5

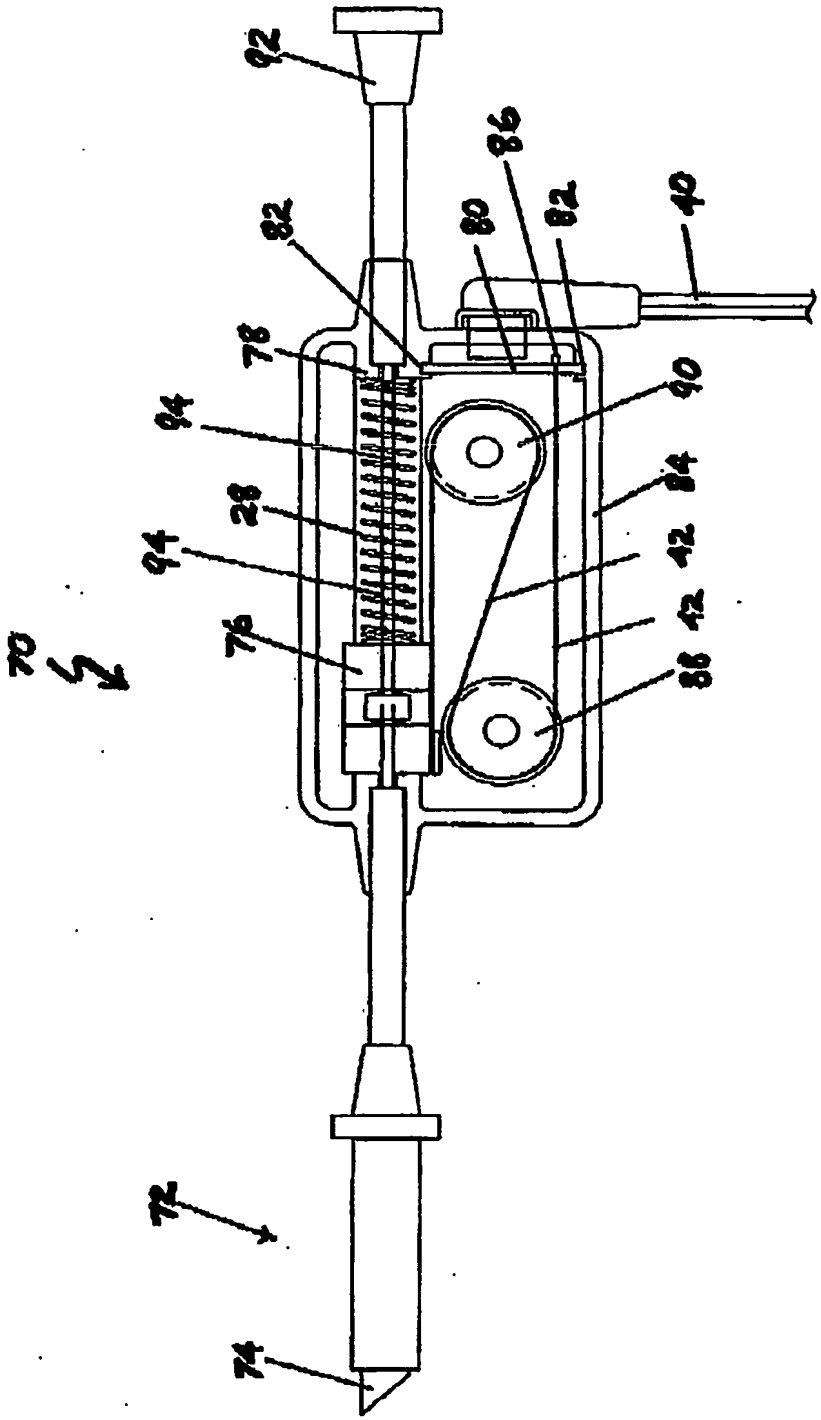

FIGURE 6

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